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Note: This abstract is very similar (but not identical) to one already cleared in June, for the 2014 AMS Severe Local Storms Conference.

Extremely Low Passive Microwave Brightness Temperatures Due To Thunderstorms

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2015 AMS Conference on Satellite Meteorology and Oceanography

Extreme events by their nature fall outside the bounds of routine experience. With imperfect or ambiguous measuring systems, it is appropriate to question whether an unusual measurement represents an extreme event or is the result of instrument errors or other sources of noise. About three weeks after the Tropical Rainfall Measuring Mission (TRMM) satellite began collecting data in Dec 1997, a thunderstorm was observed over northern Argentina with 85 GHz brightness temperatures below 50 K and 37 GHz brightness temperatures below 70 K (Zipser et al. 2006). These values are well below what had previously been observed from satellite sensors with lower resolution. The 37 GHz brightness temperatures are also well below those measured by TRMM for any other storm in the subsequent 16 years. Without corroborating evidence, it would be natural to suspect a problem with the instrument, or perhaps an irregularity with the platform during the first weeks of the satellite mission. Automated quality control flags or other procedures in retrieval algorithms could treat these measurements as errors, because they fall outside the expected bounds. But the TRMM satellite also carries a radar and a lightning sensor, both confirming the presence of an intense thunderstorm. The radar recorded 40+ dBZ reflectivity up to about 19 km altitude. More than 200 lightning flashes per minute were recorded. That same storm's 19 GHz brightness temperatures below 150 K would normally be interpreted as the result of a low-emissivity water surface (e.g., a lake, or flood waters) if not for the simultaneous measurements of such intense convection.

This paper will examine records from TRMM and related satellite sensors including SSMI, AMSR-E, and the new GMI to find the strongest signatures resulting from thunderstorms, and distinguishing those from sources of noise. The lowest brightness temperatures resulting from thunderstorms as seen by TRMM have been in Argentina in November and December. For SSMI sensors carried on five DMSP satellites examined so far, the lowest thunderstorm-related brightness temperatures have been from Argentina in November – December and from Minnesota in June-July. The Minnesota cases were associated with spotter reports of large hail, significant severe wind, and tornadoes. Those locations have the record-holders for each satellite. The lowest AMSR-E 36.5 GHz brightness temperatures associated with deep convection have been in Argentina; the lowest 89.0 GHz brightness temperatures were from Typhoon Bolaven in the Philippine Sea. This paper will show examples of cases with the lowest brightness temperatures, and map the locations of these and other storms with brightness temperatures nearly as low. The study is largely motivated by the new GMI sensor on the Global Precipitation Mission core satellite, launched in February 2014, with its high resolution expected to reveal unprecedented low brightness temperatures when extreme events are encountered.